Docket No.: 83974-US2
Application Serial No. 10/750,633

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (canceled)

2. ~~An interferometer as in claim 1, further comprising~~ (currently amended) A dispersing Fourier Transform interferometer, comprising:

a Fourier Transform Spectrometer having an input for receiving a source light and an output;

a dispersive element having an input coupled to the Fourier Transform Spectrometer output and an output for providing the resulting multiple narrowband interferogram outputs of different wavelengths representative of the source light input; and

a metrology system for determining optical path lengths internal to the interferometer.

3. (currently amended) An interferometer as in claim [[1]]2, further comprising:

a sensor including a plurality of light intensity sensing elements each separately responsive to said different wavelengths for producing a set of data of interferogram intensities I_d measured at a set of discrete lags x_i; and

a processor for receiving and processing the data to produce a spectral output having a best fit with the set of data.

4. (canceled)

5. (original) An interferometer as in claim 3, wherein the processor includes a sparse sampling algorithm for determining the best fit between a set of model interferograms and said set of data interferograms.

6. (original) An interferometer as in claim 5, wherein the sparse sampling algorithm comprises:

processing the set of data interferograms, $I_d(x_i)$, where:

$$I_d(x_i) = \int_{s_{\min}}^{s_{\max}} ds \; J_t(s) \; \cos(2\pi x_i s),$$

and where s is the wavenumber, equal to the inverse of the wavelength, $J_t(s)$ is the true spectral intensity at wavenumber s, and the subscript *t* indicates that $J_t(s)$ is the truth spectrum and is an unknown, and the wavenumbers $s_{min}(n)$ and $s_{max}(n)$ span the range of wavenumbers detected by the n^{th} member of said set of light intensity sensing elements;

choosing a model spectrum, $J_m(s_j)$, from which is inferred a model interferogram specified at a discrete set of lags x_i, $I_m(x_i)$; and

determining a difference between said model interferogram and said data interferogram and applying an optimization method to determine a model interferogram best matched to the data interferogram $I_d(x_i)$.

7. (currently amended) An interferometer as in claim 6, wherein the optimization method comprises:

establishing a model interferogram given by:

$$I_m(x_i) = \sum_{j=1}^{M-1} \int_{s_j}^{s_{j+1}} ds \; [J_m(s_j) + (s - s_j)\Delta_j] \cos(2\pi x_i s),$$

where:

$$\Delta_j = \left[\frac{J_m(s_{j+1}) - J_m(s_j)}{s_{j+1} - s_j}\right] [[.]]$$

and ε is the location of a central fringe in the model interferogram. The above expression reduces to:

$$I_m(x_i) = \sum_{j=1}^{M-1} [\alpha_{i,j} J_m(s_j) + \Delta_j \beta_{i,j}],$$

where:

$$\alpha_{i,j} = \left[\frac{\sin(2\pi x_i s_{j+1}) - \sin(2\pi x_i s_j)}{2\pi x_i}\right],$$

and

$$\beta_{i,j} = \left[\frac{(s_{j+1} - s_j)\sin(2\pi x_i s_{j+1})}{2\pi x_i}\right] + \left[\frac{\cos(2\pi x_i s_{j+1}) - \cos(2\pi x_i s_j)}{(2\pi x_i)^2}\right]$$

setting a variance of the residuals between the model interferogram and the data interferogram according to the equation:

$$\chi^2 = \frac{1}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]^2 [[.]]$$

and

obtaining a model interferogram best matched to the data interferogram according to the equations:

$$\frac{\partial \chi^2}{\partial J_m(s_j)} = \frac{2}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = 0[[.]]$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \alpha_{i,1} - \left(\frac{\beta_{i,1}}{s_2 - s_1}\right) \text{ for } j = 1,$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,j-1}}{s_j - s_{j-1}}\right) + \alpha_{i,j} - \left(\frac{\beta_{i,j}}{s_{j+1} - s_j}\right) \text{ for } 2 \le j \le M-1,$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,M-1}}{s_M - s_{M-1}}\right) \text{ for } j = M.$$

8. (currently amended) An interferometer as in claim 6, wherein the optimization method comprises: establishing a model interferogram given by:

$$I_m(x_i) = \sum_{j=1}^{M-1} \int_{s_j}^{s_{j+1}} ds \ \left[J_m(s_j) + (s - s_j)\Delta_j\right] \cos\left(2\pi x_i s\right),$$

where:

$$\Delta_j = \left[\frac{J_m(s_{j+1}) - J_m(s_j)}{s_{j+1} - s_j}\right] [[.]]$$

and ε is the location of a central fringe in the model interferogram. The above expression reduces to:

$$I_m(x_i) = \sum_{j=1}^{M-1} \left[\alpha_{i,j} J_m(s_j) + \Delta_j \beta_{i,j}\right],$$

where:

$$\alpha_{i,j} = \left[\frac{\sin\left(2\pi x_i s_{j+1}\right) - \sin\left(2\pi x_i s_j\right)}{2\pi x_i}\right],$$

and

$$\beta_{i,j} = \left[\frac{(s_{j+1} - s_j)\sin\left(2\pi x_i s_{j+1}\right)}{2\pi x_i}\right] + \left[\frac{\cos\left(2\pi x_i s_{j+1}\right) - \cos\left(2\pi x_i s_j\right)}{(2\pi x_i)^2}\right]$$

setting a variance of the residuals between the model interferogram and the data interferogram according to the equation:

$$\chi^2 = \frac{1}{n} \sum_{i=1}^{n} \left[I_m(x_i) - I_d(x_i)\right]^2 [[.]]$$

and

obtaining a model interferogram best matched to the data interferogram according to the equations:

$$\frac{\partial \chi^2}{\partial J_m(s_j)} = \frac{2}{n} \sum_{i=1}^{n} \left[I_m(x_i) - I_d(x_i)\right] \left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = 0[[.]]$$

$$\frac{\partial\left(\chi^2\right)}{\partial\epsilon}=\frac{2}{n}\sum_{i=1}^{n}\left[I_m(x_i-\epsilon)-I_d(x_i)\right]\left(\frac{\partial I_m(x_i-\epsilon)}{\partial\epsilon}\right)=0$$

and

$$\frac{\partial I_m(x_i-\epsilon)}{\partial\epsilon}=\frac{1}{x_i-\epsilon}\sum_{j=1}^{M-1}\left(A_{i,j}J_m(s_j)+B_{i,j}\Delta_j\right),$$

where:

$$A_{i,j}=-s_{j+1}\cos(z_i s_{j+1})+s_j\cos(z_i s_j)+\frac{\sin(z_i s_{j+1})}{z_i}-\frac{\sin(z_i s_j)}{z_i},$$

and

$$B_{i,j}=s_j s_{j+1}\cos(z_i s_{j+1})+(2s_{j+1}-s_j)\frac{\sin(z_i s_{j+1})}{z_i}-s_j\frac{\sin(z_i s_j)}{z_i}$$
$$-s_{j+1}^2\cos(z_i s_{j+1})+\frac{2\cos(z_i s_{j+1})}{z_i^2}-\frac{2\cos(z_i s_j)}{z_i^2},$$

where $z_i=2\pi(x_i-\varepsilon)$.

9. (original) An interferometer as in claim 3, wherein the source light is an astronomical emission.

10. (original) An interferometer as in claim 3, wherein the source light is emitted from a material upon induction of the material into an excited state.

11. (original) An interferometer as in claim 3, wherein the material is an unknown compound subjected to testing to determine the presence of possible biologically or chemically hazardous properties.

12. (currently amended) As interferometer as in claim [[1]]<u>2</u>, wherein the Fourier Transform Spectrometer comprises:

optics for receiving and collimating a source light along a first optical path;

a beamsplitter positioned for splitting the collimated source light into a second light beam along a second optical path differing from said first optical path;

a first reflector positioned along said first optical path for reflecting light transmitted through said beamsplitter back toward a beamsplitter;

a second reflector positioned along said second optical path for reflecting said second light beam back toward a beamsplitter;

and wherein the interferometer further comprises:

a sensor including a plurality of light intensity sensing elements each separately responsive to said different wavelengths for producing a set of data of interferogram intensities I_d measured at a set of discrete lags x_i; and

a processor for receiving and processing the data to produce a spectral output having a best fit with the set of data.

13. (original) An interferometer as in claim 12, wherein the processor includes a sparse sampling algorithm for determining the best fit between a set of model interferograms and said set of data interferograms.

14. (original) An interferometer as in claim 13, wherein the sparse sampling algorithm comprises:

processing the set of data interferograms, $I_d(x_i)$, where:

$$I_d(x_i) = \int_{s_{\min}}^{s_{\max}} ds\ J_t(s)\ \cos(2\pi x_i s),$$

and where s is the wavenumber, equal to the inverse of the wavelength, $J_t(s)$ is the true spectral intensity at wavenumber s, and the subscript *t* indicates that $J_t(s)$ is the truth spectrum and is an unknown, and the wavenumbers $s_{min}(n)$ and $s_{max}(n)$ span the range of wavenumbers detected by the n^{th} member of said set of light intensity sensing elements;

creating a continuous function $J_m(s)$ that is equal to $J_m(s_j)$ at each value s_j, from which is inferred the model interferogram specified at a discrete set of lags x_i, $I_m(x_i)$; and

determining the difference between said model interferogram and said data interferogram and applying an optimization method to determine a model interferogram best matched to the data interferogram $I_d(x_i)$.

15. (currently amended) An interferometer as in claim 14, wherein the optimization method comprises:

establishing a model interferogram given by:

$$I_m(x_i) = \sum_{j=1}^{M-1} \int_{s_j}^{s_{j+1}} ds \ \left[J_m(s_j) + (s - s_j)\Delta_j\right] \cos\left(2\pi x_i s\right),$$

where:

$$\Delta_j = \left[\frac{J_m(s_{j+1}) - J_m(s_j)}{s_{j+1} - s_j}\right] [[.]]$$

and ε is the location of a central fringe in the model interferogram. The above expression reduces to:

$$I_m(x_i) = \sum_{j=1}^{M-1} \left[\alpha_{i,j} J_m(s_j) + \Delta_j \beta_{i,j}\right],$$

where:

$$\alpha_{i,j} = \left[\frac{\sin\left(2\pi x_i s_{j+1}\right) - \sin\left(2\pi x_i s_j\right)}{2\pi x_i}\right],$$

and

$$\beta_{i,j} = \left[\frac{(s_{j+1} - s_j)\sin\left(2\pi x_i s_{j+1}\right)}{2\pi x_i}\right] + \left[\frac{\cos\left(2\pi x_i s_{j+1}\right) - \cos\left(2\pi x_i s_j\right)}{(2\pi x_i)^2}\right]$$

setting a variance of the residuals between the model interferogram and the data interferogram according to the equation:

$$\chi^2 = \frac{1}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]^2 [[.]]$$

and

obtaining a model interferogram best matched to the data interferogram according to the equations:

$$\frac{\partial \chi^2}{\partial J_m(s_j)} = \frac{2}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = 0[[.]]$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \alpha_{i,1} - \left(\frac{\beta_{i,1}}{s_2 - s_1}\right) \text{ for } j = 1,$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,j-1}}{s_j - s_{j-1}}\right) + \alpha_{i,j} - \left(\frac{\beta_{i,j}}{s_{j+1} - s_j}\right) \text{ for } 2 \le j \le M-1,$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,M-1}}{s_M - s_{M-1}}\right) \text{ for } j = M.$$

16. (currently amended) An interferometer as in claim 14, wherein the optimization method comprises: establishing a model interferogram given by:

$$I_m(x_i) = \sum_{j=1}^{M-1}\int_{s_j}^{s_{j+1}} ds\ \left[J_m(s_j) + (s - s_j)\Delta_j\right]\cos(2\pi x_i s),$$

where:

$$\Delta_j = \left[\frac{J_m(s_{j+1}) - J_m(s_j)}{s_{j+1} - s_j}\right] [[.]]$$

and ε is the location of a central fringe in the model interferogram. The above expression reduces to:

$$I_m(x_i) = \sum_{j=1}^{M-1} \left[\alpha_{i,j} J_m(s_j) + \Delta_j \beta_{i,j}\right],$$

where:

$$\alpha_{i,j} = \left[\frac{\sin(2\pi x_i s_{j+1}) - \sin(2\pi x_i s_j)}{2\pi x_i}\right],$$

and

$$\beta_{i,j} = \left[\frac{(s_{j+1} - s_j)\sin(2\pi x_i s_{j+1})}{2\pi x_i}\right] + \left[\frac{\cos(2\pi x_i s_{j+1}) - \cos(2\pi x_i s_j)}{(2\pi x_i)^2}\right]$$

setting a variance of the residuals between the model interferogram and the data interferogram according to the equation:

$$\chi^2 = \frac{1}{n} \sum_{i=1}^{n} \left[I_m(x_i) - I_d(x_i)\right]^2 [[.]]$$

and

obtaining a model interferogram best matched to the data interferogram according to the equations:

$$\frac{\partial \chi^2}{\partial J_m(s_j)} = \frac{2}{n} \sum_{i=1}^{n} \left[I_m(x_i) - I_d(x_i)\right] \left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = 0[[.]]$$

$$\frac{\partial (\chi^2)}{\partial \epsilon} = \frac{2}{n} \sum_{i=1}^{n} \left[I_m(x_i - \epsilon) - I_d(x_i)\right] \left(\frac{\partial I_m(x_i - \epsilon)}{\partial \epsilon}\right) = 0$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \alpha_{i,1} - \left(\frac{\beta_{i,1}}{s_2 - s_1}\right) \text{ for } j = 1,$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,j-1}}{s_j - s_{j-1}}\right) + \alpha_{i,j} - \left(\frac{\beta_{i,j}}{s_{j+1} - s_j}\right) \text{ for } 2 \le j \le M-1,$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,M-1}}{s_M - s_{M-1}}\right) \text{ for } j = M[[.]]$$

and:

$$\frac{\partial I_m(x_i - \epsilon)}{\partial \epsilon} = \frac{1}{x_i - \epsilon} \sum_{j=1}^{M-1} \left(A_{i,j} J_m(s_j) + B_{i,j} \Delta_j\right),$$

where:

$$A_{i,j} = -s_{j+1} \cos(z_i s_{j+1}) + s_j \cos(z_i s_j) + \frac{\sin(z_i s_{j+1})}{z_i} - \frac{\sin(z_i s_j)}{z_i},$$

and

$$B_{i,j} = s_j s_{j+1} \cos(z_i s_{j+1}) + (2s_{j+1} - s_j) \frac{\sin(z_i s_{j+1})}{z_i} - s_j \frac{\sin(z_i s_j)}{z_i}$$

$$- s_{j+1}^2 \cos(z_i s_{j+1}) + \frac{2\cos(z_i s_{j+1})}{z_i^2} - \frac{2\cos(z_i s_j)}{z_i^2},$$

where $z_i = 2\pi(x_i - \varepsilon)$.

17. (original) An interferometer as in claim 12, wherein the source light is an astronomical emission.

18. (original) An interferometer as in claim 12, wherein the source light is emitted from a material upon induction of the material into an excited state.

19. (original) An interferometer as in claim 12, wherein the material is an unknown compound subjected to testing to determine the presence of possible biologically or chemically hazardous properties.

20. (original) A dispersing Fourier Transform interferometer, comprising:

optics for receiving and collimating a source light along a first optical path;

a beamsplitter positioned for splitting the collimated source light into a second light beam along a second optical path substantially orthogonal to said first optical path;

a first reflector positioned along said first optical path for reflecting light transmitted through said beamsplitter back toward said beamsplitter;

a second reflector positioned along said second optical path for reflecting said second light beam back toward said beamsplitter;

a programmable drive-train coupled to at least one of said first and second reflectors for moving said coupled reflector along its associated optical path so as to introduce a variable path difference x between said first and second optical paths whereby said source light and said second light beam recombine at said beamsplitter and are recorded on a multielement detector at a variety of delays, comprising an interferogram;

a metrology detector for determining the path length difference between the two reflectors;

a dispersive element positioned along said second optical path for receiving a Fourier Transform Spectrometer output and for providing a resulting multiple narrowband interferogram outputs of different wavelengths representative of the source light input;

a sensor including a plurality of light intensity sensing elements each separately responsive to said different wavelengths for producing a set of data of interferogram intensities I_d measured at a set of discrete lags x_i; and

a processor for receiving and processing the data to produce a spectral output having a best fit with the set of data.

21. (original) An interferometer as in claim 20, wherein the processor includes a sparse sampling algorithm for determining the best fit between a model interferogram and the data interferogram.

22. (original) An interferometer as in claim 21, wherein the sparse sampling algorithm comprises:

processing the set of data interferograms, $I_d(x_i)$, where:

$$I_d(x_i) = \int_{s_{\min}}^{s_{\max}} ds\ J_t(s)\ \cos(2\pi x_i s),$$

and where s is the wavenumber, equal to the inverse of the wavelength, $J_t(s)$ is the true spectral intensity at wavenumber s, and the subscript *t* indicates that $J_t(s)$ is the truth spectrum and is an unknown, and the wavenumbers $s_{min}(n)$ and $s_{max}(n)$ span the range of wavenumbers detected by the n^{th} member of said set of light intensity sensing elements;

choosing a model spectrum, $J_m(s_j)$, from which is inferred a model interferogram specified at a discrete set of lags x_i, $I_m(x_i)$; and

determining a difference between said model interferogram and said data interferogram and applying an optimization method to determine a model interferogram best matched to the data interferogram $I_d(x_i)$.

23. (currently amended) An interferometer as in claim 22, wherein the optimization method comprises:

establishing a model interferogram given by:

$$I_m(x_i) = \sum_{j=1}^{M-1} \int_{s_j}^{s_{j+1}} ds\ \left[J_m(s_j) + (s - s_j)\Delta_j\right] \cos(2\pi x_i s),$$

where:

$$\Delta_j = \left[\frac{J_m(s_{j+1}) - J_m(s_j)}{s_{j+1} - s_j}\right] [[.]]$$

and ε is the location of a central fringe in the model interferogram. The above expression reduces to:

$$I_m(x_i) = \sum_{j=1}^{M-1} \left[\alpha_{i,j} J_m(s_j) + \Delta_j \beta_{i,j}\right],$$

where:

$$\alpha_{i,j} = \left[\frac{\sin(2\pi x_i s_{j+1}) - \sin(2\pi x_i s_j)}{2\pi x_i}\right],$$

and

$$\beta_{i,j} = \left[\frac{(s_{j+1} - s_j)\sin(2\pi x_i s_{j+1})}{2\pi x_i}\right] + \left[\frac{\cos(2\pi x_i s_{j+1}) - \cos(2\pi x_i s_j)}{(2\pi x_i)^2}\right]$$

setting a variance of the residuals between the model interferogram and the data interferogram according to the equation:

$$\chi^2 = \frac{1}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]^2 [[.]]$$

and

obtaining a model interferogram best matched to the data interferogram according to the equations:

$$\frac{\partial \chi^2}{\partial J_m(s_j)} = \frac{2}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = 0[[.]]$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \alpha_{i,1} - \left(\frac{\beta_{i,1}}{s_2 - s_1}\right) \text{ for } j = 1,$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,j-1}}{s_j - s_{j-1}}\right) + \alpha_{i,j} - \left(\frac{\beta_{i,j}}{s_{j+1} - s_j}\right) \text{ for } 2 \leq j \leq M-1,$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,M-1}}{s_M - s_{M-1}}\right) \text{ for } j = M.$$

24. (currently amended) An interferometer as in claim 22, wherein the optimization method comprises: establishing a model interferogram given by:

$$I_m(x_i) = \sum_{j=1}^{M-1}\int_{s_j}^{s_{j+1}} ds\ \left[J_m(s_j) + (s - s_j)\Delta_j\right]\cos(2\pi x_i s),$$

where:

$$\Delta_j = \left[\frac{J_m(s_{j+1}) - J_m(s_j)}{s_{j+1} - s_j}\right] [[.]]$$

and ε is the location of a central fringe in the model interferogram. The above expression reduces to:

$$I_m(x_i) = \sum_{j=1}^{M-1} \left[\alpha_{i,j} J_m(s_j) + \Delta_j \beta_{i,j}\right],$$

where:

$$\alpha_{i,j} = \left[\frac{\sin(2\pi x_i s_{j+1}) - \sin(2\pi x_i s_j)}{2\pi x_i}\right],$$

and

$$\beta_{i,j} = \left[\frac{(s_{j+1} - s_j)\sin(2\pi x_i s_{j+1})}{2\pi x_i}\right] + \left[\frac{\cos(2\pi x_i s_{j+1}) - \cos(2\pi x_i s_j)}{(2\pi x_i)^2}\right]$$

setting a variance of the residuals between the model interferogram and the data interferogram according to the equation:

$$\chi^2 = \frac{1}{n}\sum_{i=1}^{n} \left[I_m(x_i) - I_d(x_i)\right]^2 [[.]]$$

and

obtaining a model interferogram best matched to the data interferogram according to the equations:

$$\frac{\partial \chi^2}{\partial J_m(s_j)} = \frac{2}{n}\sum_{i=1}^{n} \left[I_m(x_i) - I_d(x_i)\right] \left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = 0[[.]]$$

$$\frac{\partial (\chi^2)}{\partial \epsilon} = \frac{2}{n}\sum_{i=1}^{n} \left[I_m(x_i - \epsilon) - I_d(x_i)\right] \left(\frac{\partial I_m(x_i - \epsilon)}{\partial \epsilon}\right) = 0$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \alpha_{i,1} - \left(\frac{\beta_{i,1}}{s_2 - s_1}\right) \text{ for } j = 1,$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,j-1}}{s_j - s_{j-1}}\right) + \alpha_{i,j} - \left(\frac{\beta_{i,j}}{s_{j+1} - s_j}\right) \text{ for } 2 \le j \le M-1,$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,M-1}}{s_M - s_{M-1}}\right) \text{ for } j = M[[.]]$$

and:

$$\frac{\partial I_m(x_i - \epsilon)}{\partial \epsilon} = \frac{1}{x_i - \epsilon} \sum_{j=1}^{M-1} \left(A_{i,j} J_m(s_j) + B_{i,j} \Delta_j\right),$$

where:

$$A_{i,j} = -s_{j+1} \cos(z_i s_{j+1}) + s_j \cos(z_i s_j) + \frac{\sin(z_i s_{j+1})}{z_i} - \frac{\sin(z_i s_j)}{z_i},$$

and

$$B_{i,j} = s_j s_{j+1} \cos(z_i s_{j+1}) + (2 s_{j+1} - s_j) \frac{\sin(z_i s_{j+1})}{z_i} - s_j \frac{\sin(z_i s_j)}{z_i}$$

$$- s_{j+1}^2 \cos(z_i s_{j+1}) + \frac{2\cos(z_i s_{j+1})}{z_i^2} - \frac{2\cos(z_i s_j)}{z_i^2},$$

where $z_i = 2\pi(x_i - \varepsilon)$.

25. (original) An interferometer as in claim 22, wherein the source light is an astronomical emission.

26. (original) An interferometer as in claim 22, wherein the source light is emitted from a material upon induction of the material into an excited state.

27. (original) An interferometer as in claim 22, wherein the material is an unknown compound subjected to testing to determine the presence of possible biologically or chemically hazardous properties.

28. (original) A method of determining a spectrum of a light source, comprising:

receiving and collimating a source light along a first optical path;

transmitting a first part of the collimated source light further along said first optical path while reflecting a second part of the collimated source light along a second optical path;

reflecting back said first part of said collimated source light along said first optical path;

reflecting back said second part of said collimated source light along said second optical path;

introducing a path length difference x between said first and second optical paths;

recombining said back-reflected first and second parts of said collimated source light;

dispersing said recombined light into a plurality of different wavelengths;

separately sensing an intensity I of each of said plurality of different wavelengths to thereby produce a set of data of interferogram intensities I_d measured at a set of discrete lags x_i; and

processing the data so as to produce a spectral output having a best fit with the set of data.

29. (original) A method as in claim 28, wherein the data processing includes applying a sparse sampling algorithm for determining the best fit between a model interferogram and the data interferogram.

30. (original) A method as in claim 29, wherein the sparse sampling algorithm comprises:

processing the set of data interferograms, $I_d(x_i)$, where:

$$I_d(x_i) = \int_{s_{\min}}^{s_{\max}} ds\ J_t(s)\ \cos(2\pi x_i s),$$

and where s is the wavenumber, equal to the inverse of the wavelength, $J_t(s)$ is the true spectral intensity at wavenumber s, and the subscript *t* indicates that $J_t(s)$ is the truth spectrum and is an unknown, and the wavenumbers $s_{min}(n)$ and $s_{max}(n)$ span the range of wavenumbers detected by the n^{th} member of said set of light intensity sensing elements;

choosing a model spectrum, $J_m(s_j)$, from which is inferred a model interferogram specified at a discrete set of lags x_i, $I_m(x_i)$; and

determining a difference between said model interferogram and said data interferogram and applying an optimization method to determine a model interferogram best matched to the data interferogram $I_d(x_i)$.

31. (currently amended) A method as in claim 30, wherein the optimization method comprises:

establishing a model interferogram given by:

$$I_m(x_i) = \sum_{j=1}^{M-1} \int_{s_j}^{s_{j+1}} ds\ \left[J_m(s_j) + (s - s_j)\Delta_j\right] \cos(2\pi x_i s),$$

where:

$$\Delta_j = \left[\frac{J_m(s_{j+1}) - J_m(s_j)}{s_{j+1} - s_j}\right] [[.]]$$

and ε is the location of a central fringe in the model interferogram. The above expression reduces to:

$$I_m(x_i) = \sum_{j=1}^{M-1} \left[\alpha_{i,j} J_m(s_j) + \Delta_j \beta_{i,j}\right],$$

where:

$$\alpha_{i,j} = \left[\frac{\sin(2\pi x_i s_{j+1}) - \sin(2\pi x_i s_j)}{2\pi x_i}\right],$$

and

$$\beta_{i,j} = \left[\frac{(s_{j+1} - s_j)\sin(2\pi x_i s_{j+1})}{2\pi x_i}\right] + \left[\frac{\cos(2\pi x_i s_{j+1}) - \cos(2\pi x_i s_j)}{(2\pi x_i)^2}\right]$$

setting a variance of the residuals between the model interferogram and the data interferogram according to the equation:

$$\chi^2 = \frac{1}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]^2 [[.]]$$

and

obtaining a model interferogram best matched to the data interferogram according to the equations:

$$\frac{\partial\chi^2}{\partial J_m(s_j)} = \frac{2}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = 0[[.]]$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \alpha_{i,1} - \left(\frac{\beta_{i,1}}{s_2 - s_1}\right) \text{ for } j = 1,$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,j-1}}{s_j - s_{j-1}}\right) + \alpha_{i,j} - \left(\frac{\beta_{i,j}}{s_{j+1} - s_j}\right) \text{ for } 2 \le j \le M-1,$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,M-1}}{s_M - s_{M-1}}\right) \text{ for } j = M.$$

32. (currently amended) A method as in claim 30, wherein the optimization method comprises: establishing a model interferogram given by:

$$I_m(x_i) = \sum_{j=1}^{M-1}\int_{s_j}^{s_{j+1}} ds\ \left[J_m(s_j) + (s - s_j)\Delta_j\right]\cos(2\pi x_i s),$$

where:

$$\Delta_j = \left[\frac{J_m(s_{j+1}) - J_m(s_j)}{s_{j+1} - s_j}\right] [[.]]$$

and ε is the location of a central fringe in the model interferogram. The above expression reduces to:

$$I_m(x_i) = \sum_{j=1}^{M-1} \left[\alpha_{i,j} J_m(s_j) + \Delta_j \beta_{i,j}\right],$$

where:

$$\alpha_{i,j} = \left[\frac{\sin(2\pi x_i s_{j+1}) - \sin(2\pi x_i s_j)}{2\pi x_i}\right],$$

and

$$\beta_{i,j} = \left[\frac{(s_{j+1} - s_j)\sin(2\pi x_i s_{j+1})}{2\pi x_i}\right] + \left[\frac{\cos(2\pi x_i s_{j+1}) - \cos(2\pi x_i s_j)}{(2\pi x_i)^2}\right]$$

setting a variance of the residuals between the model interferogram and the data interferogram according to the equation:

$$\chi^2 = \frac{1}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]^2 [[.]]$$

and

obtaining a model interferogram best matched to the data interferogram according to the equations:

$$\frac{\partial \chi^2}{\partial J_m(s_j)} = \frac{2}{n}\sum_{i=1}^{n}\left[I_m(x_i) - I_d(x_i)\right]\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = 0[[.]]$$

$$\frac{\partial\left(\chi^2\right)}{\partial \epsilon} = \frac{2}{n}\sum_{i=1}^{n}\left[I_m(x_i - \epsilon) - I_d(x_i)\right]\left(\frac{\partial I_m(x_i - \epsilon)}{\partial \epsilon}\right) = 0$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \alpha_{i,1} - \left(\frac{\beta_{i,1}}{s_2 - s_1}\right) \text{ for } j = 1,$$

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,j-1}}{s_j - s_{j-1}}\right) + \alpha_{i,j} - \left(\frac{\beta_{i,j}}{s_{j+1} - s_j}\right) \text{ for } 2 \le j \le M-1,$$

and

$$\left(\frac{\partial I_m(x_i)}{\partial J_m(s_j)}\right) = \left(\frac{\beta_{i,M-1}}{s_M - s_{M-1}}\right) \text{ for } j = M[[.]]$$

and:

$$\frac{\partial I_m(x_i - \epsilon)}{\partial \epsilon} = \frac{1}{x_i - \epsilon} \sum_{j=1}^{M-1} \left(A_{i,j} J_m(s_j) + B_{i,j} \Delta_j\right),$$

where:

$$A_{i,j} = -s_{j+1} \cos(z_i s_{j+1}) + s_j \cos(z_i s_j) + \frac{\sin(z_i s_{j+1})}{z_i} - \frac{\sin(z_i s_j)}{z_i},$$

and

$$B_{i,j} = s_j s_{j+1} \cos(z_i s_{j+1}) + (2 s_{j+1} - s_j) \frac{\sin(z_i s_{j+1})}{z_i} - s_j \frac{\sin(z_i s_j)}{z_i}$$

$$- s_{j+1}^2 \cos(z_i s_{j+1}) + \frac{2\cos(z_i s_{j+1})}{z_i^2} - \frac{2\cos(z_i s_j)}{z_i^2},$$

where $z_i = 2\pi(x_i - \varepsilon)$.

33. (original) A method as in claim 28, wherein the source light is an astronomical emission.

34. (original) A method as in claim 28, wherein the source light is emitted from a material upon induction of the material into an excited state.

35. (original) A method as in claim 28, wherein the material is an unknown compound subjected to testing to determine the presence of possible biologically or chemically hazardous properties.